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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/945,535	08/30/2001	Kie Y. Ahn	1303.026US1	2681

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EXAMINER	
BLUM, DAVID S	

ART UNIT	PAPER NUMBER
2813	

DATE MAILED: 12/10/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/945,535	AHN ET AL.	
	Examiner	Art Unit	
	David S Blum	2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *01 October 2004* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,2,4-10,12-15,17-23,25-31,33-37,51,52 and 54-56* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,2,4-10,12-15,17-23,25-31,33-37,51,52 and 54-56* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

This action is in response to the amendment filed 10/01/04.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 1-2, 4, 14-15, 17, 51-52, and 54-56 rejected under 35 U.S.C. 103(a) as being unpatentable over Maiti (US006020024A) in view of Park (US 5,795,808) and Brasen (US 4,725,887) and Ma (US006207589B1).

Maiti teaches all of the positive steps of claims 1-2, 4, 14-15, 17, 51-52, and 54-56 except for depositing an amorphous metal layer by electron beam evaporation at a range of 5.16 eV to 7.8 eV and it's purity level. Maiti teaches a zirconium (group IVB) layer is deposited on a transistor body region by an evaporation technique and oxidized to form an oxide layer (column 3 lines 30-52) between first and second source/drain regions (figure 3). A gate (20) is coupled to the metal oxide layer. It is understood that Maiti teaches vapor deposition of a metal oxide or sputtering and oxidation of a metal layer and that the instant application teaches electron beam evaporation as an improvement to sputtering and oxidizing the metal.

Regarding the process steps recited in "product by process claims" 51-54, the process steps are given little weight in product or device claims and Maiti teaches the device of claims 51-54. In re Thorpe, 777 F.2d 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985).

Park deposits a zirconium film by electron beam deposition (column 4 lines 16-17) at 99.0 purity or higher (column 4 line 25) thus a substantially single element . Although Park does not teach forming an amorphous layer by electron beam evaporation, it is noted that the specification teaches "although the amorphous form is preferred, the material chosen for oxidation, such as zirconium is also acceptable in its crystalline form" (page 7 lines 17-19).

Note that the specification contains no disclosure of either the critical nature of the claimed dimensions or of any unexpected results arising there from. Where patentability is said to be based upon particular chosen dimensions or upon another variable recited in the claim, the Applicant must show that the chosen dimensions are critical. In re Woodruff, 919 F.2d 1515, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

Brasen teaches forming an amorphous layer of a type IVB metal layer by electron beam evaporation (column 2 lines 23 and 31-32 and column 3 lines 12-14).

Both of the above references, taken alone or collectively, teach that electron beam deposition is a well-known art recognized equivalent method to sputtering, Brasen teaching an amorphous type IVB metal layer as in the instant claims.

Regarding the limitation of forming the layer with a conduction band offset in a range of 5.16-7.8 eV, as the process steps are identical and there is no teaching as to modifying the process to achieve the specified range, it is considered to be a range of common use, and one skilled in the requisite art would know how to optimize the process to achieve the range.

These ranges are considered to involve routine optimization while it has been held to be within the level of ordinary skill in the art. As noted in In re Aller (105 USPQ233), the selection of reaction parameters such as temperature and concentration would have been obvious:

> "Normally, it is to be expected that a change in temperature, or in concentration, or in both, would be an unpatentable modification. Under some circumstances, however, changes such as these may impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not merely degree from the results of the prior art. Such ranges are termed "critical ranges and the applicant has the burden of proving such criticality.... More particularly, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation."
> In re Aller 105 USPQ233, 255 (CCPA 1955). See also In re Waite 77 USPQ 586 (CCPA 1948); In re Scherl 70 USPQ 204 (CCPA 1946); In re Irmscher 66 USPQ 314 (CCPA 1945); In re Norman 66 USPQ 308 (CCPA 1945); In re Swenson 56 USPQ 372 (CCPA 1942); In re Sola 25 USPQ 433 (CCPA 1935); In re Dreyfus 24 USPQ 52 (CCPA 1934).

One skilled in the requisite art at the time of the invention would have used any ranges or exact figures suitable to the method in the process of depositing material regarding energy levels using prior knowledge, experimentation, and observation with the apparatus used in order to optimize the process and produce the structure desired to the parameters desired.

Regarding the limitation that the metal layer be substantially amorphous, as recited above, the specification teaches this to be non-critical. Maiti is silent as to whether the metal layer has crystal structure or is amorphous prior to oxidation. Park. Park only mentions that the metal chosen to form the layer may be from group IV metal elements with a hexagonal crystal structure (column 4 lines 19-23). This refers to the metal group, but not the metal layer formed. Ma, forms a gate oxide ((column 1 lines 13-15) by depositing a metal layer by an evaporation deposition method (column 2 lines 54-55 and 65-67) and then oxidizing the metal layer to form the metal oxide (column 3 lines 1-4). Ma teaches the layer remains amorphous (column 3 lines 54-55), thus the layer as formed is amorphous. Ma teaches that the reduces crystallinity (amorphous state) reduces electrical leakage (column 1 lines 53-58).

It would be obvious to one skilled in the requisite art at the time of the invention to modify Maiti by substituting electron beam evaporation as it is a well-known art recognized equivalent to sputtering (as taught by Brasen in forming an amorphous type IVB metal layer) and to form the layer in an amorphous state to reduce electrical leakage (as taught by Ma column 1 lines 53-58).

3. Claims 22-23, 25, 30-31, and 33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Maiti (US006020024A) in view of admitted prior art (pages 1-4) in view of Park (US 5,795,808) and Brasen (US 4,725,887) and Ma (US006207589B1).

Maiti teaches all of the positive steps of claims 22-23, 25, 30-31 and 33, except for the application of wordlines, sourcelines, bitlines and system busses and depositing the metal by electron beam evaporation and the purity level. Maiti teaches a zirconium (group IVB) layer is deposited on a transistor body region by an evaporation technique and oxidized to form an oxide layer (column 3 lines 30-52) between first and second source/drain regions (figure 3). A gate (20) is coupled to the metal oxide layer. It is understood that Maiti teaches vapor deposition of a metal oxide or sputtering and oxidation of a metal layer and that the instant application teaches electron beam evaporation as an improvement to sputtering and oxidizing the metal.

Maiti teaches that the device formed is a metal oxide field effect transistor with a high k metal gate for IC's. The admitted prior art (pages 1-4) teaches that these devices are commonly used in IC's particularly processor chips, mobile telephones, and memory devices. These devices commonly use wordlines, sourcelines, bitlines and system busses.

Park deposits a zirconium film by electron beam deposition (column 4 lines 16-17) at 99.0 purity or higher (column 4 line 25). Although Park does not teach forming an amorphous layer by electron beam evaporation, it is noted that the specification teaches "although the amorphous form is preferred, the material chosen for oxidation, such as zirconium is also acceptable in its crystalline form" (page 7 lines 17-19).

Note that the specification contains no disclosure of either the critical nature of the claimed dimensions or of any unexpected results arising there from. Where patentability is said to be based upon particular chosen dimensions or upon another variable recited in the claim, the Applicant must show that the chosen dimensions are critical. In re Woodruff, 919 F.2d 1515, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).
Brasen teaches forming an amorphous layer of a type IVB metal layer by electron beam evaporation (column 2 lines 23 and 31-32 and column 3 lines 12-14).
Both of the above references, taken alone or collectively, teach that electron beam deposition is a well-known art recognized equivalent method to sputtering, Brasen teaching an amorphous type IVB metal layer as in the instant claims.

Regarding the limitation that the metal layer be substantially amorphous, as recited above, the specification teaches this to be non-critical. Maiti is silent as to whether the metal layer has crystal structure or is amorphous prior to oxidation. Park. Park only mentions that the metal chosen to form the layer may be from group IV metal elements with a hexagonal crystal structure (column 4 lines 19-23). This refers to the metal group, but not the metal layer formed. Ma, forms a gate oxide ((column 1 lines 13-15) by depositing a metal layer by an evaporation deposition method (column 2 lines 54-55 and 65-67) and then oxidizing the metal layer to form the metal oxide (column 3 lines 1-4). Ma teaches the layer remains amorphous (column 3 lines 54-55), thus the layer as formed is amorphous. Ma teaches that the reduces crystallinity (amorphous state) reduces electrical leakage (column 1 lines 53-58).

One skilled in the requisite art at the time of the invention would modify Maiti by completing the device and circuit to form IC's, particularly processor chips, mobile telephones, and memory (arrays) devices (which include wordlines, sourcelines, bitlines and system busses) as taught by the admitted prior art to be conventional practice and to include substituting electron beam evaporation as it is a well known art recognized equivalent to sputtering and to form the layer in an amorphous state to reduce electrical leakage (as taught by Ma column 1 lines 53-58).

4. Claims 5-7, 18-20, 26-28, and 34-36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Maiti (US006020024A) in view of the admitted prior art and Park (US 5,795,808) and Brasen (US 4,725,877) and Ma (US006207589B1) as applied to claims 1, 14, 30, above, and further in view of Yano (US005810923A).

Maiti, Park, Brasen, Ma, and the admitted prior art teach all of the positive steps of claims 5-7, 18-20, 26-28, and 34-36 except for the temperature of the substrate, oxidizing in atomic oxygen, and oxidizing temperatures. Maiti is silent as to the substrate temperature and oxidizing temperature. Yano teaches electron beam evaporation of zirconium oxide at substrate temperatures of 300-700 degrees Celsius (column 10 line 5). Although Yano is depositing zirconium oxide, not zirconium as Maiti, Yano suggests reasonable temperatures for the deposition and oxidation of the metal. These ranges are considered to involve routine optimization as recited above.

Yano deposits the metal layer with atomic oxygen (electron beam) suggesting that Maiti could anneal in atomic oxygen rather than molecular oxygen. "the oxidizing gas used herein may be oxygen, ozone, atomic oxygen and NO2." (column 21 lined 35-36), thus teaching an art recognized equivalence for oxygen and atomic oxygen in oxidizing zirconium.

One skilled in the requisite art at the time of the invention would have modified Maiti, Park, Brasen, and the admitted prior art by substituting atomic oxygen for molecular oxygen as suggested by Yano and used any ranges or exact figures suitable to the method in the process of deposition regarding temperature using prior knowledge, experimentation, and observation with the apparatus used in order to optimize the process and produce the metal oxide layer structure desired to the parameters desired.

5. Claims 8-10, 12-13, and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Maiti (US006020024A) in view Park (US 5,795,808), Brasen (US 4,725,877), and Ma (US006207589B1) and in further view of Moise (US006211035B1) and Yano (US005810923A)..

Maiti, Park, Brasen, and Ma, teaches all of the positive steps of claims 8-10, 12-13, and 21 as recited above, except for annealing the metal layer (type IVB, zirconium) in a plasma of krypton and oxygen. Moise teaches layers of ZrO2 can be formed either as an oxide or a metal layer that is oxidized (column 10 lines 53-57). Moise also teaches a

method for oxidizing within the used equipment by using an oxygen-containing plasma along with an optional inert gas (column 8 lines 11-13), defining inert gas as helium, neon, argon, krypton, or xenon (column 12 lines 23-24).

Park deposits a zirconium film by electron beam deposition (column 4 lines 16-17) at 99.0 purity or higher (column 4 line 25). Although Park does not teach forming an amorphous layer by electron beam evaporation, it is noted that the specification teaches "although the amorphous form is preferred, the material chosen for oxidation, such as zirconium is also acceptable in its crystalline form" (page 7 lines 17-19).
Note that the specification contains no disclosure of either the critical nature of the claimed dimensions or of any unexpected results arising there from. Where patentability is said to be based upon particular chosen dimensions or upon another variable recited in the claim, the Applicant must show that the chosen dimensions are critical. In re Woodruff, 919 F.2d 1515, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).
Brasen teaches forming an amorphous layer of a type IVB metal layer by electron beam evaporation (column 2 lines 23 and 31-32 and column 3 lines 12-14).
Both of the above references, taken alone or collectively, teach that electron beam deposition is a well-known art recognized equivalent method to sputtering, Brasen teaching an amorphous type IVB metal layer as in the instant claims.

Although Yano is depositing zirconium oxide, not zirconium as Maiti, Yano suggests reasonable temperatures for the deposition and oxidation of the metal. These ranges are considered to involve routine optimization as recited above.

One skilled in the requisite art at the time of the invention would modify Maiti by substituting electron beam evaporation as it is a well known art recognized equivalent to sputtering and including krypton as the inert gas during oxidation as known to be conventional practice in the art.

6. Claims 29, and 37 are rejected under 35 U.S.C. 103(a) as being unpatentable over Maiti (US006020024A) in view of admitted prior art and Park (US 5,795,808) Brasen (US 4,725,877) and Ma (US006207589B1) and in further view of Moise (US006211035B1).

Maiti, Park, Brasen, and Ma, and the admitted prior art teach all of the positive steps of claims 29 and 37 as recited above except for annealing the metal layer (type IVB, zirconium) in a plasma of krypton and oxygen. Moise teaches layers of ZrO2 can be formed either as an oxide or a metal layer that is oxidized (column 10 lines 53-57). Moise also teaches a method for oxidizing within the used equipment by using an oxygen-containing plasma along with an optional inert gas (column 8 lines 11-13), defining inert gas as helium, neon, argon, krypton, or xenon (column 12 lines 23-24).

One skilled in the requisite art at the time of the invention would modify Maiti and the admitted prior art by including krypton as the inert gas during oxidation as known to be conventional practice in the art.

Information Disclosure Statement

7. The information disclosure statement filed 11/15/04 has been received, but not yet scanned into the system. The IDS is therefore currently unavailable to the examiner. The IDS and references will be considered with a future action.

Response to Arguments

8. Applicant's arguments filed 8/31/01 have been fully considered but they are not persuasive.

The applicant argues that the structure of Maiti differs from that of the instant application as Maiti teaches a high dielectric constant material on a silicon nitride layer grown on the surface of a semiconductor and the instant application does not have a silicon nitride layer on the semiconductor wafer. However, the claim only limits the metal layer to be oxidized to being "on the body region". Maiti reads on this.

The applicant also argues that Maiti does not teach evaporation deposition, oxidation of the metal, a single element, and the use of electron beams. Maiti does teach an

evaporation technique, but not the one of the instant application, and does oxidize the metal. Other references were used to teach and suggest the other positive steps.

The applicant argues that Brasen does not teach about metal oxides for gate dielectrics. The examiner never made such a statement. Brasen teaches forming an amorphous layer of a type IVB metal layer by electron beam evaporation, thus teaching it is known to form such a layer. This suggests that one skilled in the art upon reading Brasen would know to modify Maiti to include electron beam evaporation deposition. Further, Park teaches electron beam evaporation deposition of a IVB metal for oxidation. The applicant has not argued this, only arguing that Park teaches ion implantation for the source and drain regions, an argument that has no bearing on the claims.

The applicant argues that Ma does nothing to cure the above noted shortcomings of Maiti. However, Ma was used as a teaching that it is known to deposit metal in the amorphous state, . Ma teaches depositing metal, oxidizing it and the material remains in the amorphous state. "Remains" means the material was amorphous prior to oxidation.

In regard to claims 22-23, 25, 30-31, and 33, the applicant argues against the rejection for reasons stated above. The examiner's response is as above.

In regard to claims 5-7, 18-20, 26-28, and 34-36, the applicant argues that the deposition of metal oxide of Yano is dissimilar from that of the present application. Yano

deposits zirconium oxide not zirconium (to be oxidized) as in the instant application. However, the temperatures for deposition are set for evaporating zirconium, not oxygen (a gas at room temperatures). The temperatures taught by Yano are therefore reasonable for the process of the instant application. Also, as other cited references deposit zirconium by electron beam evaporation, these temperatures are known, even though the other references do not report the ranges of temperatures.

In regard to claims 8-10, 12-13, and 13, the applicant argues that Moise is toward capacitors and does not cure the deficiencies in the suggested prior art discussed above. Moise is directed toward capacitors, but was used only to teach annealing parameters for a type IVB metal layer. The annealing teachings would hold for such a material, the location of the material or end use on the semiconductor notwithstanding. Regarding ""the deficiencies discussed above" the examiner responded above and will not repeat the arguments here.

In regard to claims 29 and 37, the applicant argues the applicant argues against the rejection for reasons stated above. The examiner's response is as above.

Conclusion

9. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to David S. Blum whose telephone number is (757)-272-1687) and e-mail address is David.blum@USPTO.gov .

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead Jr., can be reached at (571)-272-1702. Our facsimile number all patent correspondence to be entered into an application is (703) 872-9306. The facsimile number for customer service is (703)-872-9317.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

David S. Blum

December 9, 2004